

What I claim is:

1. For use with a mode-locked laser source propagating pulsed laser energy characterized by a repetition rate, an optical sensor apparatus for measuring a measurable parameter, the optical sensor comprising:  
an optical resonator disposed to receive at least a portion of the pulsed laser energy, the optical resonator having a sensing surface responsive to changes in the measurable parameter at the sensing surface and the optical resonator defining a cavity forming a variable gap that varies in response to the sensing surface and that is positioned such that the repetition rate of the pulsed laser energy changes in response to changes in the measurable parameter.
2. The optical sensor apparatus of claim 1, wherein the optical resonator further comprises a waveguide for propagating the at least a portion of the laser energy.
3. The optical sensor apparatus of claim 2, wherein the waveguide further comprises a core and a cladding surrounding the core such that the at least a portion of the laser energy propagates within the core under total internal reflection.
4. The optical sensor apparatus of claim 3, wherein the cavity is disposed at least partially within the core.
5. The optical sensor apparatus of claim 3, wherein the cavity is disposed entirely within the cladding.
6. The optical sensor of claim 1, wherein the optical resonator further comprises a first reflector at an entrance end of the optical resonator and a second reflector at an exit end of the optical resonator.

7. The optical sensor of claim 1, wherein the optical resonator comprises a ring resonator.
8. The optical sensor of claim 7, wherein the ring resonator is formed of an optical fiber.
9. The optical sensor of claim 7, wherein the ring resonator is formed in an optical substrate.
10. The optical sensor of claim 7, wherein the ring resonator is formed of a photonic crystal structure.
11. The optical sensor of claim 1, wherein the resonator is a dielectric resonator.
12. The optical sensor of claim 1, wherein the measurable parameter is selected from the group consisting of pressure, temperature, flow rate, material composition, force, and strain.
13. The optical sensor of claim 1, wherein the optical resonator comprises a microdisc.
14. The optical sensor of claim 13, wherein the laser source is a distributed feedback laser in the form of a vertical cavity surface emitting laser.
15. The optical sensor of claim 1, wherein the optical resonator is a microsphere having a first hemisphere and a second hemisphere spaced apart by the variable gap, the sensing surface being the outer shell of the microsphere.
16. The optical sensor of claim 1, wherein the optical resonator is a microsphere disposed within a receiving cavity formed in a dielectric module, the dielectric

module having a membrane that flexes in response to changes in the measurable parameter at the sensing surface to change the repetition rate of the laser energy.

17. The optical sensor of claim 1, further comprising a measuring apparatus for measuring the repetition rate of the laser energy.

18. The optical sensor of claim 1, wherein the optical resonator is external to the mode-locked laser source.

19. The optical sensor of claim 1, wherein the optical resonator is internal to the mode-locked laser source, forming a laser cavity of the mode-locked laser source.

20. For use with a laser source, an optical sensor apparatus for use in measuring a measurable parameter, the optical sensor apparatus comprising:

an optical resonator having a sensing surface responsive to changes in the measurable parameter at the sensing surface, the optical resonator defining a resonant frequency that is dependent upon the measurable parameter at the sensing surface, the optical resonator being disposed such that a laser signal from the optical sensor apparatus has a frequency at the resonant frequency, the optical resonator further defining a cavity forming a variable gap that varies in response to the sensing surface.

21. The optical sensor apparatus of claim 20, wherein the optical resonator is internal to the laser source and forms a laser cavity of the laser source.

22. The optical sensor apparatus of claim 20, wherein the optical resonator forms a resonator that is external to the laser source.

23. The optical sensor apparatus of claim 20, wherein the optical resonator further comprises a waveguide for propagating at least a portion of the laser signal, the waveguide including the cavity.
24. The optical sensor apparatus of claim 20, wherein the waveguide further comprises a core and a cladding surrounding the core such that the at least a portion of the laser signal propagates within the core under total internal reflection.
25. The optical sensor apparatus of claim 20, wherein the optical resonator further comprises a first reflector at an entrance end of the optical resonator and a second reflector at an exit end of the optical resonator.
26. The optical sensor apparatus of claim 20, wherein the optical resonator comprises a ring resonator.
27. The optical sensor apparatus of claim 20, wherein the measurable parameter is selected from the group consisting of pressure, temperature, flow rate, material composition, force, and strain.
28. The optical sensor apparatus of claim 20, wherein the laser source is a distributed feedback laser and the optical resonator comprises is a microdisc.
29. The optical sensor apparatus of claim 20, wherein the optical resonator is a microsphere having a first hemisphere and a second hemisphere spaced apart by a variable gap that changes in response to changes in the measurable parameter at the sensing surface of the optical resonator, the sensing surface being the outer shell of the microsphere.
30. The optical sensor apparatus of claim 20, wherein the optical resonator is a microsphere disposed within a receiving cavity formed in a dielectric module, the

dielectric module having a membrane that flexes in response to changes in the measurable parameter at the sensing surface.

31. The optical sensor apparatus of claim 20, further comprising a measuring apparatus for measuring the frequency of the laser signal.

32. The optical sensor apparatus of claim 20, wherein the optical resonator is a dielectric resonator.

33. The optical sensor apparatus of claim 20, wherein the optical resonator is formed of a lasing material.

34. The optical sensor apparatus of claim 20, wherein the optical resonator is formed of a non-lasing material.

35. An apparatus for modulating, based on a measurable parameter, the output of a laser source producing a laser energy, the apparatus comprising:  
a coupler coupled to receive the laser energy; and  
an external high Q resonator characterized by a resonant frequency that varies in response to changes in the measurable parameter, the high Q resonator coupled to the coupler for modulating the laser energy into an information carrying laser signal having a frequency at the resonant frequency of the high Q resonator.

36. The apparatus of claim 35, wherein the coupler is waveguide coupler.

37. The apparatus of claim 35, wherein the measurable parameter is selected from the group consisting of pressure, temperature, flow rate, material composition, force, and strain.

38. The apparatus of claim 35, wherein the laser source has a laser cavity characterized by a first Q value, Q1, and the high Q resonator is characterized by a second Q value, Q2, that is substantially higher than Q1.

39. The apparatus of claim 38, wherein Q2 is at least 100.

40. A variable frequency resonator comprising an optical resonator having a sensing surface and having a waveguide having a cavity defining a variable gap, the optical resonator characterized by a resonant frequency that is dependent upon the variable gap which is disposed to alter the resonant frequency of the optical resonator in response to changes in the measurable parameter at the sensing surface.

41. The variable frequency resonator of claim 36, wherein the optical resonator further comprises a first reflector disposed at an entrance face of the waveguide and a second reflector disposed at an exit face of the waveguide, the first reflector and second reflector defining a resonant length through the waveguide.

42. The variable frequency resonator of claim 40, wherein the waveguide is an optical fiber having a core and a cladding.

43. The variable frequency resonator of claim 40, wherein the waveguide is a ring resonator.

44. The variable frequency resonator of claim 40, wherein the waveguide is formed in a photonic crystal.

45. A method of sensing a measurable parameter, the method comprising the steps of:

providing a laser signal;

providing a resonator characterized by a resonant frequency;

providing a variable gap that varies in response to changes in the measurable parameter, where variations to the variable gap alter the resonant frequency;

propagating at least a portion of the laser signal through the resonator such that the laser signal has a frequency at the resonant frequency; and

sensing changes in the measurable parameter, such that said sensed changes to the measurable parameter alter the frequency of the laser signal.

46. The method of claim 45, wherein the resonator is formed of a dielectric material and wherein the step of providing the resonator further comprises the steps of:

placing a first reflector at an entrance side of the dielectric material; and

placing a second reflector at an exit side of the dielectric material, where the first reflector is partially transmissive at the frequency of the laser signal.

47. The method of claim 46, wherein the dielectric material is an optical fiber having an inlet end and an outlet end and the step of providing the resonator further comprises the steps of:

forming a first Bragg reflector at the inlet end; and

forming a second Bragg reflector at the outlet end.

48. The method of claim 45, wherein the laser signal is produced by a laser source and the resonator is external to laser source, the step of propagating the laser signal further comprising coupling the laser signal from the laser source to the resonator.

49. The method of claim 45, wherein the resonator is formed of a lasing material.

50. The method of claim 45, wherein the step of sensing changes in the measurable parameter comprises the step of providing a sensing surface communicating with the variable gap.

51. A method of sensing a measurable parameter, the method comprising the steps of:

- providing a pulsed laser signal characterized by a repetition rate;
- providing a resonator;
- providing a variable gap that varies in response to changes in the measurable parameter;
- propagating at least a portion of the pulsed laser signal through the resonator; and
- sensing variations in the variable gap such that the repetition rate of the pulsed laser signal changes in response to variations in the variable gap.

52. The method of claim 51, wherein the resonator is formed of a dielectric material and wherein the step of providing the resonator further comprises the steps of:

- placing a first reflector at an entrance side of the dielectric material; and
- placing a second reflector at an exit side of the dielectric material, where the first reflector is partially transmissive at the frequency of the laser signal.

53. The method of claim 52, wherein the dielectric material is an optical fiber having an inlet end and an outlet end and the step of providing the resonator further comprises the steps of:

- forming a first Bragg reflector at the inlet end; and
- forming a second Bragg reflector at the outlet end.



54. The method of claim 51, wherein the step sensing variations further comprises the step of providing a sensing surface communicating with the variable gap.

55. The method of claim 51, wherein the pulsed laser signal is produced by a mode-locked laser source and the resonator is external to the mode-locked laser source, the step of propagating the pulsed laser signal further comprising coupling the at least a portion of the pulsed laser signal from the mode-locked laser source to the resonator.

56. The method of claim 51, wherein the resonator is formed of a lasing material forming a mode-locked laser source that produces the pulsed laser signals.

57. For use with a light source, an optical resonator having a variable gap that varies in response to changes in a measurable parameter, the optical resonator receiving light energy from the light source to alter a characteristic of the light energy in response to variations in the variable gap.

58. The optical resonator of claim 57, wherein the light energy is a continuous wave and the characteristic is frequency.

59. The optical resonator of claim 57, wherein the light energy is a pulsed laser energy and the characteristic is repetition rate.

60. The optical resonator of claim 57, wherein the light source is a LED source.

61. The optical resonator of claim 57, wherein the light source is a laser source.